

PATENT COOPERATION TREATY

PCT

INTERNATIONAL PRELIMINARY REPORT ON PATENTABILITY



(Chapter II of the Patent Cooperation Treaty)

(PCT Article 36 and Rule 70)

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Applicant's or agent's file reference TS 6440 PCT		FOR FURTHER ACTION		See Form PCT/PEA/416
International application No. PCT/EP2004/052899		International filing date (day/month/year) 10.11.2004	Priority date (day/month/year) 12.11.2003	
International Patent Classification (IPC) or national classification and IPC E21B43/02, E21B7/00, E21B7/28, E21B43/19, E21B43/26				
Applicant SHELL INTERNATIONALE RESEARCH MAATSCHAPPIJ B.V. et				
<p>1. This report is the international preliminary examination report, established by this International Preliminary Examining Authority under Article 35 and transmitted to the applicant according to Article 36.</p> <p>2. This REPORT consists of a total of 4 sheets, including this cover sheet.</p> <p>3. This report is also accompanied by ANNEXES, comprising:</p> <p>a. <input checked="" type="checkbox"/> sent to the applicant and to the International Bureau) a total of 5 sheets, as follows:</p> <p><input checked="" type="checkbox"/> sheets of the description, claims and/or drawings which have been amended and are the basis of this report and/or sheets containing rectifications authorized by this Authority (see Rule 70.16 and Section 607 of the Administrative Instructions).</p> <p><input type="checkbox"/> sheets which supersede earlier sheets, but which this Authority considers contain an amendment that goes beyond the disclosure in the international application as filed, as indicated in item 4 of Box No. I and the Supplemental Box.</p> <p>b. <input type="checkbox"/> (sent to the International Bureau only) a total of (indicate type and number of electronic carrier(s)) , containing a sequence listing and/or tables related thereto, in computer readable form only, as indicated in the Supplemental Box Relating to Sequence Listing (see Section 802 of the Administrative Instructions).</p>				
<p>4. This report contains indications relating to the following items:</p> <p><input checked="" type="checkbox"/> Box No. I Basis of the opinion</p> <p><input type="checkbox"/> Box No. II Priority</p> <p><input type="checkbox"/> Box No. III Non-establishment of opinion with regard to novelty, inventive step and industrial applicability</p> <p><input type="checkbox"/> Box No. IV Lack of unity of invention</p> <p><input checked="" type="checkbox"/> Box No. V Reasoned statement under Article 35(2) with regard to novelty, inventive step or industrial applicability; citations and explanations supporting such statement</p> <p><input type="checkbox"/> Box No. VI Certain documents cited</p> <p><input type="checkbox"/> Box No. VII Certain defects in the international application</p> <p><input type="checkbox"/> Box No. VIII Certain observations on the international application</p>				
Date of submission of the demand 09.09.2005		Date of completion of this report 17.11.2005		
Name and mailing address of the international preliminary examining authority:  European Patent Office - P.B. 5818 Patentlaan 2 NL-2280 HV Rijswijk - Pays Bas Tel. +31 70 340 - 2040 Tx: 31 651 epo nl Fax: +31 70 340 - 3016		Authorized Officer Schouten, A Telephone No. +31 70 340-4088 		

**INTERNATIONAL PRELIMINARY REPORT
ON PATENTABILITY**

International application No.
PCT/EP2004/052899

Box No. I Basis of the report

1. With regard to the **language**, this report is based on the international application in the language in which it was filed, unless otherwise indicated under this item.
- ☐ This report is based on translations from the original language into the following language , which is the language of a translation furnished for the purposes of:
- ☐ international search (under Rules 12.3 and 23.1(b))
 - ☐ publication of the international application (under Rule 12.4)
 - ☐ international preliminary examination (under Rules 55.2 and/or 55.3)
2. With regard to the **elements*** of the international application, this report is based on *(replacement sheets which have been furnished to the receiving Office in response to an invitation under Article 14 are referred to in this report as "originally filed" and are not annexed to this report):*

Description, Pages

4-8 as originally filed
1-3 received on 16.09.2005 with letter of 16.09.2005

Claims, Numbers

1-10 received on 16.09.2005 with letter of 16.09.2005

Drawings, Sheets

1/2, 2/2 as originally filed

- ☐ a sequence listing and/or any related table(s) - see Supplemental Box Relating to Sequence Listing
3. ☐ The amendments have resulted in the cancellation of:
- ☐ the description, pages
 - ☐ the claims, Nos.
 - ☐ the drawings, sheets/figs
 - ☐ the sequence listing (*specify*):
 - ☐ any table(s) related to sequence listing (*specify*):
4. ☐ This report has been established as if (some of) the amendments annexed to this report and listed below had not been made, since they have been considered to go beyond the disclosure as filed, as indicated in the Supplemental Box (Rule 70.2(c)).
- ☐ the description, pages
 - ☐ the claims, Nos.
 - ☐ the drawings, sheets/figs
 - ☐ the sequence listing (*specify*):
 - ☐ any table(s) related to sequence listing (*specify*):

* If item 4 applies, some or all of these sheets may be marked "superseded."

**INTERNATIONAL PRELIMINARY REPORT
ON PATENTABILITY**

International application No.
PCT/EP2004/052899

Box No. V Reasoned statement under Article 35(2) with regard to novelty, inventive step or industrial applicability; citations and explanations supporting such statement

1. Statement

Novelty (N)	Yes: Claims	1-10
	No: Claims	
Inventive step (IS)	Yes: Claims	1-10
	No: Claims	
Industrial applicability (IA)	Yes: Claims	1-10
	No: Claims	

2. Citations and explanations (Rule 70.7):

see separate sheet

Re Item V

**Reasoned statement with regard to novelty, inventive step or industrial applicability;
citations and explanations supporting such statement**

1 Reference is made to the following documents:

D1: US-A-5.386.875

D2: US2003/0070805

D3: US-A-5.337.825

2.1 Since none of the cited prior art documents discloses the subject-matter of independent claim 1, it is considered to be new (Article 33(2) PCT).

2.2 The problem to be solved by the present invention may be regarded as relieving stresses in the wellbore wall in an effective way.

The solution to this problem proposed in claim 1 of the present application is considered as involving an inventive step (Article 33(3) PCT) for the following reasons: D1, D2 and D3 disclose methods of relieving stresses around the wellbore wall by creating essentially flat slots or perforations. By creating a slot in the wellbore wall that is wedge shaped in a cross-sectional plane of the wellbore, and whereby the width of the slot decreases in radially outward direction, stresses are relieved more effectively compared to creating essentially flat slots or perforations.

2.3 Claims 2-10 are dependent on claim 1 and as such also meet the requirements of the PCT with respect to novelty and inventive step.

(87)

METHOD OF REDUCING SAND PRODUCTION FROM A WELLBORE

The present invention relates to a method of reducing inflow of rock particles from an earth formation into a wellbore for the production of hydrocarbon fluid. Often the reservoir rock is loosely consolidated, so that it tends to disintegrate and flow into the wellbore under the influence of hydrocarbon fluid flowing through the pore spaces.

Such inflow of rock particles, generally referred to as sand production, is a frequently occurring problem in the industry of hydrocarbon fluid production, as the produced sand particles tend to erode production equipment such as tubings and valves. Conventional methods of sand control include the installation of supporting perforated liners or screens, which allow the hydrocarbon fluid to pass but exclude the sand particles. Also, gravel packs are installed between the liners or screens and the wellbore wall to control sand production. Although such liners, screens and gravel packs have often been successfully applied, there are potential drawbacks such as clogging of the perforations, screens or gravel packs leading to diminished fluid production. Hence there is a need for an improved method of sand control.

US patents 5,337,825 and 5,386,875 and US patent application US 2003/0070805 disclose methods wherein stresses in the formation surrounding a wellbore are alleviated by means of shots or fractures with essentially parallel walls.

It is an object of the invention to provide an improved method of reducing inflow of rock particles into

a wellbore for the production of hydrocarbon fluid, which method overcomes the drawbacks of the prior art.

5 In accordance with the invention there is provided a method of reducing inflow of rock particles from an earth formation into a wellbore for the production of hydrocarbon fluid, the method comprising creating a zone of reduced compressive stiffness around the wellbore by removing rock material from the wall of the wellbore, wherein the step of removing rock material from the wellbore wall comprises creating a slot in the wellbore wall characterised in that the slot is wedge shaped in a cross-sectional plane of the wellbore, and that the width of the slot decreases in radially outward direction.

10 It is thereby achieved that stress concentrations in the rock material at, or adjacent to, the wellbore wall are relieved. Such stress concentrations are due to the presence of the wellbore in the rock formation, whereby the originally undisturbed stresses in the rock formation have become disturbed. The disturbed stresses include high shear stresses in the near wellbore region, which often lead to local failure of the rock formation thereby inducing sand production. By reducing the compressive stiffness in a zone around the wellbore, the relatively high shear stresses in the near-wellbore region are relieved so that the risk of local failure of the rock formation is reduced.

20 It is preferred that the step of removing rock material from the wellbore wall is carried out in an open-hole section of the wellbore, that is to say, an uncased section of the wellbore.

30 Suitably the step of removing rock material from the wellbore wall comprises removing rock material from at least one elongate section of the wellbore wall.

Preferably each elongate section has a longitudinal axis extending in axial direction of the wellbore.

It is to be understood that the elongate section does not need to extend parallel to the longitudinal axis of the wellbore, but can, for example, extend in the form of a helix along the wellbore wall.

Generally the earth formation surrounding the wellbore is subjected to stresses including first, second and third principal stresses. It is preferred that said elongate section extends radially in a direction substantially perpendicular to a selected one of said principal stresses.

Suitably said elongate section extends radially in a direction substantially perpendicular to the largest a selected one of said principal stresses.

In case the wellbore extends substantially vertically, it is preferred that said elongate section extends radially in a direction substantially perpendicular to the largest horizontal principal stress.

In case the wellbore extends substantially horizontally, it is preferred that said elongate section extends radially in a direction substantially perpendicular to the vertical principal stress.

The slots or perforations can be open (i.e. filled with gas or liquid) or filled with a flexible material.

The invention will be described hereinafter in more detail and by way of example, with reference to the accompanying drawings in which:

Fig. 1A schematically shows a wellbore in which an embodiment of the method of the invention is applied, at an initial stage of the method;

Fig. 1B shows the wellbore of Fig. 1A at a final stage of the method;

16. 09. 2005

TS 6440

(87)

C L A I M S

1. A method of reducing inflow of rock particles from an earth formation into a wellbore for the production of hydrocarbon fluid, the method comprising creating a zone of reduced compressive stiffness around the wellbore by removing rock material from the wall of the wellbore, wherein the step of removing rock material from the wellbore wall comprises creating a slot in the wellbore wall; characterised in that the slot is wedge shaped in a cross-sectional plane of the wellbore, and that the width of the slot decreases in radially outward direction.

2. The method of claim 1, wherein the rock material is removed from the wellbore wall in an open-hole portion of the wellbore.

3. The method of claim 1 or 2, wherein the step of removing rock material from the wellbore wall comprises removing rock material from at least one elongate section of the wellbore wall.

4. The method of claim 3, wherein each said elongate section has a longitudinal axis extending in axial direction of the wellbore.

5. The method of claim 3 or 4, wherein the earth formation surrounding the wellbore is subjected to stresses including first, second and third principal stresses, and wherein said elongate section extends radially in a direction substantially perpendicular to a selected one of said principal stresses.

6. The method of claim 5 wherein said elongate section extends radially in a direction substantially

perpendicular to the largest one of said principal stresses.

7. The method of claim 5 or 6 wherein the wellbore extends substantially vertically, and wherein said
5 elongate section extends radially in a direction substantially perpendicular to the largest horizontal principal stress.

8. The method of claim 5 or 6 wherein the wellbore extends substantially horizontally, and wherein said
10 elongate section extends radially in a direction substantially perpendicular to the vertical principal stress.

9. The method of any one of claims 1-8, wherein the step of creating the slot includes

15 a) lowering a string provided with a fluid jet cutter into the wellbore;

b) pumping a fluid through the string so as to induce the fluid jet cutter to eject a fluid jet against the wall of the wellbore thereby creating a cut in the
20 wellbore wall; and

c) simultaneously with step b, moving the string in axial direction through the wellbore.

10. The method of claim 1, wherein the slot substantially extends in axial direction of the wellbore.